Space Weather Technical Forecast

Issued on Sunday, 08 January 2023 at 00:46 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares likely, slight chance of X-class flares throughout.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Moderate, with an M1 flare at 07/0053 UTC originating from AR3182, which remains the largest and most complex region on the visible disc. This region appears to be showing a couple of small delta spots, now it has become more clearly visible. There are four other sunspot regions on the visible disc, of which AR3181 is the next largest. It has grown in the last 24 hours, with an increase in penumbral area which may develop into a delta spot although it doesn't quite appear to be a delta just yet. AR3183 is smaller than these two regions, but does have some minor magnetic complexity. There are two further regions, one of which appears fairly stable and the other is fading. No Earth-directed CMEs have been observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR at L1, showed signs of a waning High Speed Stream (HSS). Wind speeds were at slightly elevated levels, but declined slightly from around 470 km/s to near 430 km/s. Density was largely average. Total IMF, Bt, was mostly weak at 8 nT or below. The north-south component, Bz, varied weakly between +6/-7 nT. Phi angle was negative (towards the Sun) throughout. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at background levels. High energy electron flux (greater than 2MeV) has been at mostly background levels. The 24-hour integrated electron fluence was on a fairly steady trend well below the Active threshold, reaching 1.64e6 integrated pfu at 08/0001 UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is likely to be Low to Moderate, with a slight chance of X-class flares through the forecast period, these most likely from AR3182.

Solar Wind / Geomagnetic Activity: No Earth directed CMEs are currently expected. Solar wind speeds are slightly elevated at the moment, and are expected to continue to decline through Day 1 and into Day 2 (08-09 Jan), probably to near background levels. The next feature of interest is CH62/-, with the HSS likely to arrive either at the end of Day 2, or more likely on Day 3 (10 Jan). Geomagnetic activity is expected to be mostly Quiet to Unsettled at first, increasing with the HSS arrival either later on Day 2 or on Day 3 to become Unsettled to Active, with a slight chance of a G1/Minor Storm. Activity then slowly declining through Day 4 (11 Jan).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES-16 is likely to remain at background levels throughout. However, there is a risk of an increase should any significant flares occur, giving a slight chance of exceeding the S1/Minor Storm threshold.
Electron fluence is likely to remain below the Active (1e8 integrated pfu) threshold, but possibly on a slight rising trend.

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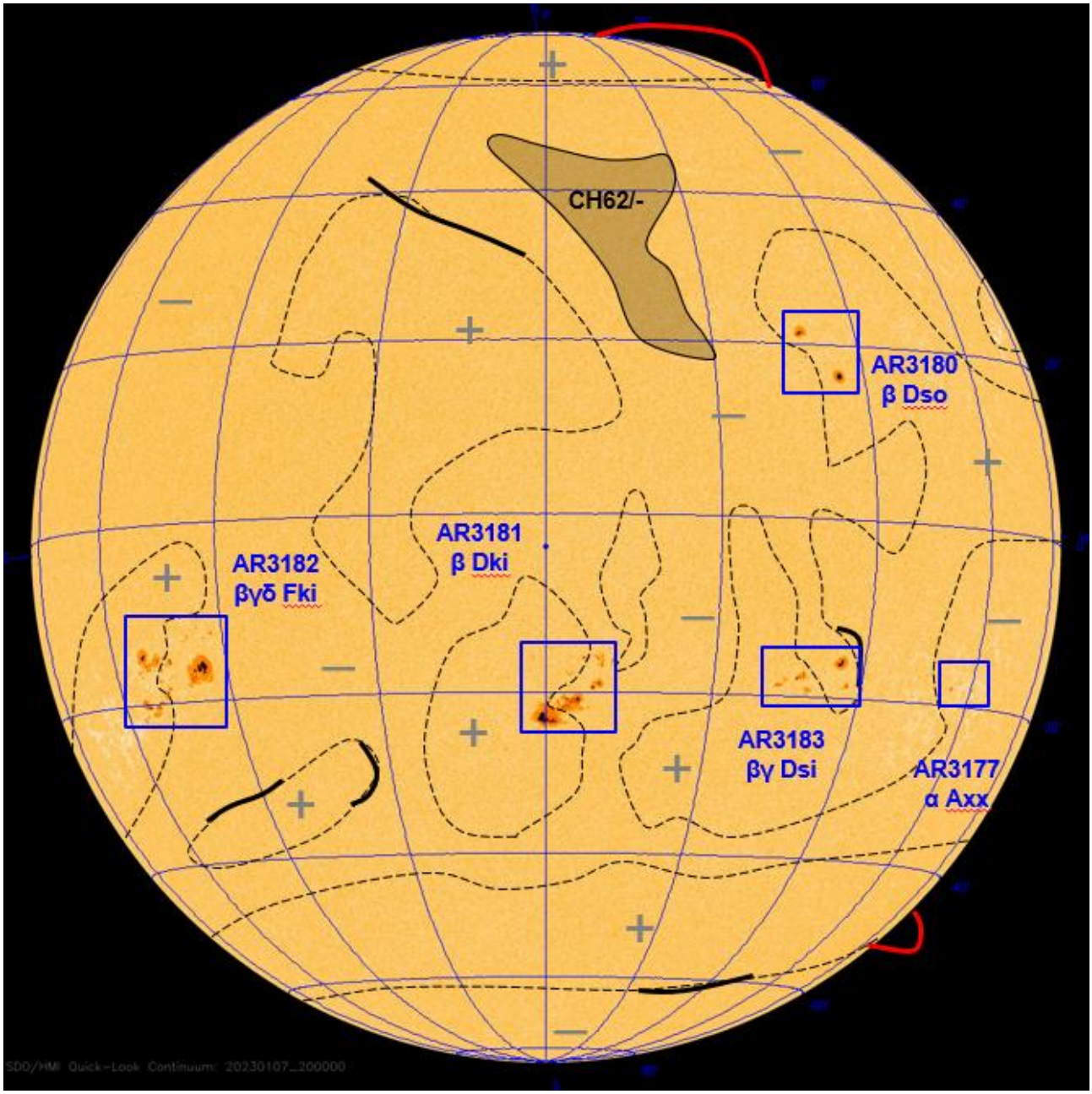
Figure 1. Solar Analysis Valid 07/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth directed CMEs are currently expected.

Solar wind speeds are slightly elevated at the moment, likely indicative of a waning HSS from either CH60 or CH61. Wind speeds are expected to continue to decline through Day 1 and into Day 2 (08-09 Jan), probably to near background levels. This fits with STEREO-A data, which is now about a day upwind of Earth, and is showing a decline below 400 km/s. The next feature of interest is CH62/-, with the HSS likely to arrive either at the end of Day 2, or more likely on Day 3 (10 Jan). This feature was faintly visible on the previous rotation but didn't produce a HSS. It is much more clearly visible this time around, suggesting it is more intense and therefore more likely to give an increase in wind speeds on this rotation. The timing of arrival had to be estimated from empirical techniques due to the lack of persistence data and it being too far ahead for STEREO to provide any useful data at this time.

Geomagnetic activity is expected to be mostly Quiet to Unsettled at first, increasing with the HSS arrival either later on Day 2 or on Day 3 to become Unsettled to Active, with a slight chance of a G1/Minor Storm. Activity then slowly declining through Day 4 (11 Jan).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
*	*	*	*	*	*	*

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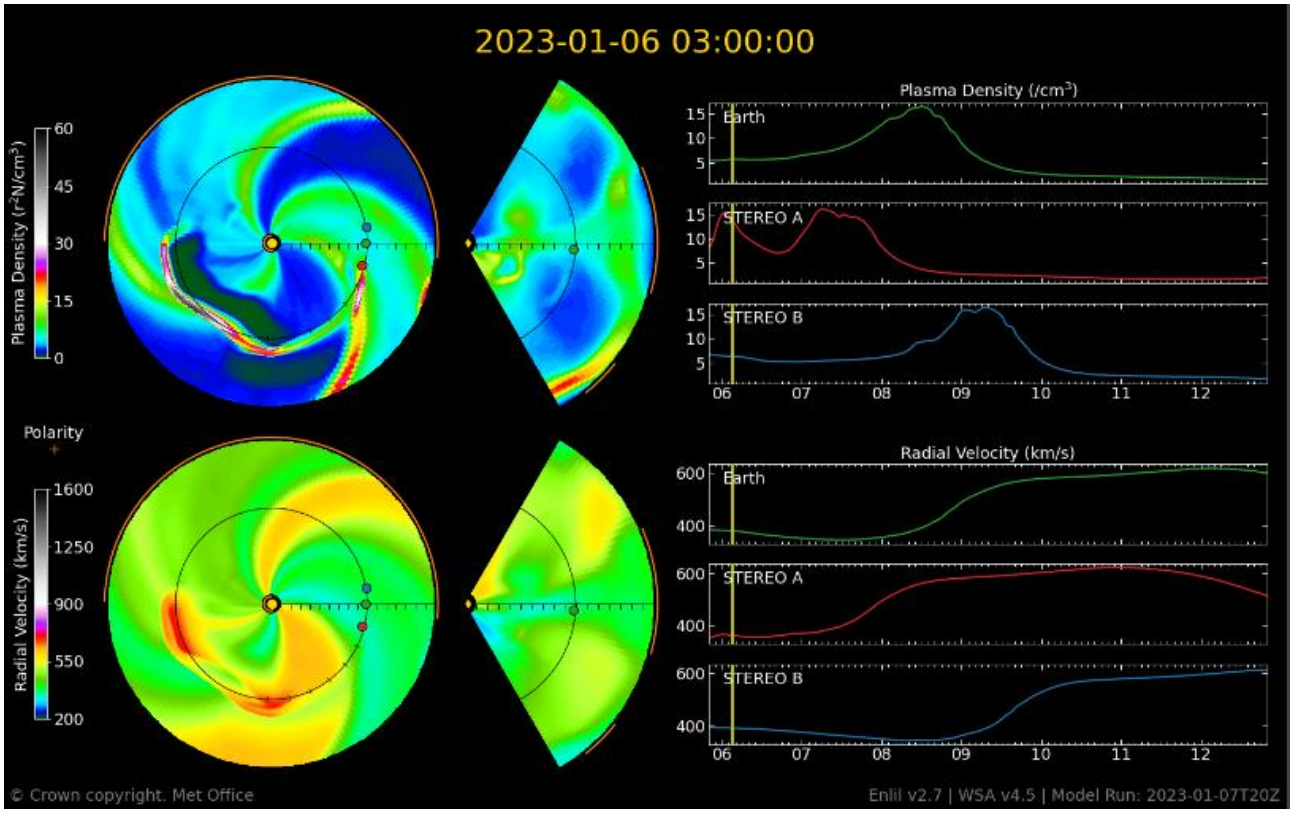
Figure 2: MOSWOC Enlil showing a wind speed increase early on 09 January. This may be a little early, with the HSS arrival more likely later on 09 into 10 January.



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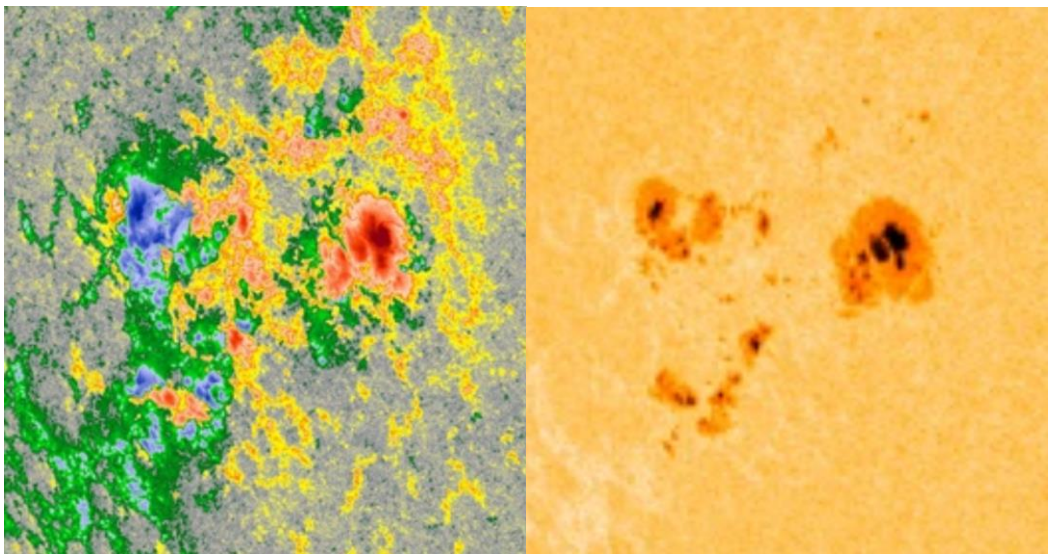
Radio Blackouts - X-Ray Flares:
There are currently five numbered sunspot regions on the visible. AR3182 (Fki/Beta-Gamma-Delta) remains the largest and most magnetically complex region on the disc. There appear to be a couple of small delta spots in the trailing area, now we can see this region more clearly, and this region currently presents the highest flare risk of all the spots on the disc. AR3181 (Dki/Beta) showed some growth over the last 24 hours, with the penumbra increasing on the trailing spot. Although this doesn't quite appear to be a delta spot at this time it could become one if the growth continues. AR3183 (Dsi/Beta-Gamma) is much smaller than the other two areas mentioned, but has some minor magnetic complexity. These two regions therefore also present a flare risk, but lower than that from AR3182. AR3180 in the north has been stable lately and AR3177 is fading.

Solar activity has been Moderate over the past 24 hours, with an M1 flare observed at 07/0053 UTC, originating from AR3182. Solar activity is likely to be mainly Low to Moderate with a slight chance of X-class flares. There is the potential for further regions to rotate around from the east limb. Recent EUVI imagery does show some bright flux just around the east limb, and far side seismographs are indicating plenty of activity of the far side.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 3: SDO intensitygram and magnetogram of AR3182, showing a couple of small delta spots in the trailing portion.



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) measured by GOES-16 is currently at background levels.
However, any significant flares will bring a risk of proton flux rising, with a slight chance of exceeding the S1/Minor Storm threshold. This risk increases slightly through the period, due mainly to the risk presented by AR3182 as it rotates further westwards across the disc, towards a position where it is more likely to connect with Earth for proton events.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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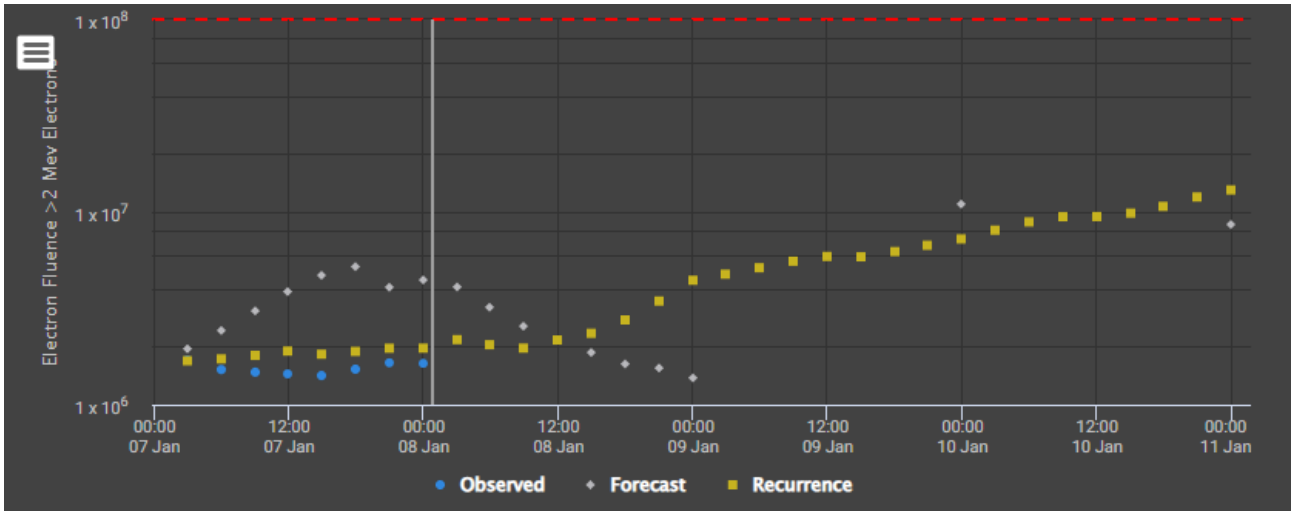
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has been at largely background levels. Whilst some electron charging may have occurred from the recent HSS, it was a relatively short lived feature and as such significant charging is unlikely to have occurred. Electron flux levels may start to rise in the coming days, but this is expected to be modest, perhaps reaching Moderate levels at the diurnal peaks. The onset of the next HSS from CH62 either later on Day 2 or more likely during Day 3 (09-10 Jan) is expected to cause a further suppression of flux levels. This HSS is expected to be stronger than the previous, but any electron response is more likely to occur after the end of this four day period.

Electron fluence is therefore expected to remain below the Active (1e8 integrated pfu) threshold, perhaps on a slight rising trend. MOSWOC REFM is currently forecasting a slight rising trend below Active, which is considered good guidance. Confidence in fluence remaining below Active is reasonable, but lower for the timing of any increase especially towards the end of the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	10	10	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM showing a slight rise in electron fluence but below the Active threshold.



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